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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 09/856,761 | 05/23/2001 | Shmuel Akerman | 032/02161 | 3117 |

7590 08/07/2003

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| EXAMINER | |
|---|---|
| SEALEY, LANCE W | |
| **ART UNIT** | **PAPER NUMBER** |
| 2671 | 4 |

DATE MAILED: 08/07/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

| Office Action Summary | Application No. | Applicant(s) | |
|---|---|---|---|
| | 09/856,761 | AKERMAN ET AL. | |
| | Examiner | Art Unit | |
| | Lance W. Sealey | 2671 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☐ Responsive to communication(s) filed on *23 May 2001* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *1-49* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-6,18,19,23,28,32,40-44 and 46-49* is/are rejected.

7)☒ Claim(s) *7-17,20-22,24-27,29-31,33-39 and 45* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

**Priority under 35 U.S.C. §§ 119 and 120**

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☒ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

**Attachment(s)**

1) ☒ Notice of References Cited (PTO-892)
2) ☒ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) *3* .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

## DETAILED ACTION

### *Allowed and Allowable Subject Matter*

1. Claims 7-17, 20-22, 24-27, 29-31, 33-39 and 45 are objected to as being dependent upon rejected base claims, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

2. The following is a statement of reasons for the indication of allowable subject matter: No prior art suggests or implies, in a method of forming a high spatial resolution perspective rendering from a low spatial resolution voxel data set, determining a normal to a boundary between opacity classes identified by a cast ray in the process of determining a boundary visualization value (claim 7); providing an index array indicating for at least some of said voxels if a class-boundary does not pass near the voxel (claim 8); calculation of surface lighting in the determination of the boundary visualization value (claim 12); ceasing ray casting if said accumulated opacity is over a threshold (claim 13); points sampled along a cast ray in a voxel data set are separated by a step size which is dependent on the opacity value at the sampling points (claim 14); interpolating between voxels near said point wherein said interpolation is dependent on a distance between said sampled point and said vantage point (claim 20); performing (g) in claim 1 wherein (g) comprises sparely casting rays and determining whether to cast one additional ray between cast rays (claim 24); performing (g) in claim 1 wherein (g) comprises progressively increasing the density of raycasting (claim 29); defining a window in or near the voxel space through which to cast rays (claim 33); accumulation of opacity comprises updating a storage value CT as follows: CT=CT*T^step_size, where T is a transparency value corresponding to the opacity value (claim 39); and accumulating said

point associated visualization values comprises selectively accumulating values based on front surface detection (claim 45). Claims 9-11 are allowable because claim 8 is allowable; claim 15-17 are allowable because claim 14 is allowable; claim 21 is allowable because claim 20 is allowable; claims 25-27 are allowable because claim 24 is allowable; claims 30-31 are allowable because claim 29 is allowable; claims 34-38 are allowable because claim 33 is allowable.

***Claim Rejections - 35 USC § 112***

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

4. Claim 19 recites the limitation "interpolating between voxels *near said point*" and "transforming said interpolated voxel value into an opacity value *for said point*" (italics added by examiner for emphasis).

5. There is insufficient antecedent basis for these limitations. Since claim 19 depends on claim 1, is "said point" one of the points sampled during raycasting (claim 1(a)), or one of the points associated with a material class (claims 1(c) and (d))? Appropriate correction is required.

***Claim Rejections - 35 USC § 103***

6. The following is a quotation of 35 U.S.C. § 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described

as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

7. Claims 1-6, 18, 22-23, 32, 41 and 49 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Argiro (U.S. Pat. No. 6,219,059) in view of Drebin et al. ("Drebin", U.S. Pat. No. 5,381,518).

8. Argiro, in disclosing interactive control of voxel attributes using selectable characteristics, also discloses, with respect to claim 1, a method of forming a high spatial resolution perspective rendering from a low spatial resolution voxel data set, comprising:

(a) raycasting at least one ray from a predetermined location into the voxel space by sampling points along said ray in a space (col.2, ll.25-38);

(b) accumulating the effect of opacity along the ray path, using opacity values at said sampling points, into a ray storage value (col.2, ll.25-38); and

(d) determining if a ray passes from a point in a first material class to a point in a second material class, using on the opacity values of the points (col.2, ll.25-38).

9. However, Argiro does not disclose the other elements of claim 1. These elements are disclosed by the Drebin method and apparatus for imaging volume data using voxel values, namely:

(c) associating points along the cast ray (disclosed by Argiro, col.2, ll.25-38) with material classes, each material class of a plurality of possible material classes being associated with a set of opacity values (Drebin, col.10, ll.44-61);

(e) providing at least one association of a boundary visualization value with a boundary between two different material classes (color values--col.10, ll.42-61);

(f) if the ray is determined to pass between classes, accumulating a boundary visualization value associated with a boundary between the two classes into said ray storage value (col.8, ll.3-13);

(g) repeating at least (a), (b), (d) and (f) for a plurality of cast rays (col.1, ll.24-29. If rays will be cast in performing surgery, a lot of rays will certainly be cast because many surgeries are performed); and

(h) forming a high spatial resolution perspective rendering from said determining ray storage values (col.8, ll.9-12; col.10, ll.44-47).

10. Therefore, it would have been obvious to one of ordinary skill in the art to have modified the Argiro voxel attribute control system in view of the Drebin method of imaging volume data. Such a modification to Argiro would avoid imprecise rendering (Drebin, col.8, ll.41-42, 51-54, 58-67).

11. The other claims in this rejection will now be considered. Concerning claim 2, Drebin discloses determining the location of boundaries between material opacity classes during ray casting at col.11, ll.46-53.

12. Regarding claim 3, Drebin discloses boundaries between material opacity classes are set to be at a position between two points of different material opacity classes at col.10, ll.42-61.

13. With respect to claim 4, Drebin discloses boundaries between material opacity classes determined by examining at least one additional sampling point between the two

points of different classes at col.9, ll.43-58.

14. Concerning claim 5, Drebin discloses examining at least one additional sampling point between the points of different classes comprising repeating examining sampling points between points of different classes until a desired precision of boundary determination is achieved at col.9, ll.43-58.

15. Regarding claim 6, Drebin discloses calculating said boundary visualization value during said ray casting at col.8, ll.3-13.

16. With respect to claim 18, Drebin discloses providing a definition of voxel value intervals for each class prior to said ray casting (in col.10, ll.50-56, groups of bones, fat, etc. ("material classes") are identified by opacity; in col.5, ll.55-66, it is disclosed that voxel values are composed of four 12-bit words and one of the four 12-bit words represents opacity. So the voxel value intervals would be organized around the opacity values.).

17. Concerning claim 22, Argiro does not specifically disclose the predetermined location from which the ray is cast being within the voxel, but the disclosure of this element is obvious because even if a ray starts from a predetermined location outside the voxel, it passes through voxels, which means at one point it is inside a voxel space continuing through the voxel space. At that point the determining location is within the voxel space. (See col.2, ll.30-38).

18. Regarding claim 23, Argiro discloses the voxel data set comprising a medical imaging data set (voxel data set: col.2, l.29; probably a medical imaging dataset because of the Background of the Invention—col.1, ll.20-32).

19. With respect to claim 32, Drebin discloses rendering a formed perspective in a display in FIG.5 and col.11, ll.46-56).

20. Concerning claim 41, Argiro discloses the voxel data set generated by one of CT (Computerized Tomography), MRI (Magnetic Resonance Imaging), Ultrasound, a geophysical survey, a meterological survey, a scientific simulation, an animation model having more than two dimensions and a set of simultaneous equations (the scope of Argiro apparently includes the use of ultrasound, CT and MRI; see col.1, ll.20-27).

21. Finally, concerning claim 49(a), Argiro discloses the voxel data set at col.2, ll.27-29, and Drebin discloses the memory in 26(a) of FIG.2; regarding claim 49(b), Drebin discloses the computer processor for applying the method of forming a high spatial resolution perspective rendering from a low spatial resolution voxel data set (host computer **10**, FIG.1); and with respect to claim 49(c), Drebin discloses a second memory for storing said formed perspective rendering in 26(d) of FIG.2.

22. In view of the foregoing, the examiner concludes that claims 1-6, 18, 22-23, 32, 41 and 49 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Argiro and Drebin.

23. Claims 19, 28, 42-44, 46 and 47 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Argiro in view of Drebin and further in view of Knittel et al. ("Knittel," U.S. Pat. No. 6,297,799).

24. Neither Argiro nor Drebin disclose, with respect to claim 19, interpolating between voxels near said point and transforming said interpolated voxel value into an opacity value for said point. These elements are taught by the Knittel real-time volume

rendering system. Interpolating between voxels at said point is disclosed at col.4, ll.32-43, and transforming said interpolated voxel value into an opacity value for said point is disclosed at col.4, ll.20-31.

25. Therefore, it would have been obvious to one of ordinary skill in the art to have modified the Argiro-Drebin rendering system in view of the Knittel volume rendering system. Such a modification to Argiro-Drebin would increase quality and realism (Knittel, col.2, ll.25-29).

26. The other claims in this rejection will now be considered. Concerning claim 28, Knittel discloses interpolating between stored values of cast rays at col.4, ll.18-22.

27. Regarding claim 42, Knittel discloses each voxel having associated therewith a visual representation value and comprising determining a visualization value associated with a sampled point from the voxel associated visual representation values; and accumulating said point associated visualization value into said stored value (col.4, ll.32-48—values need to be stored to be compared; see ll.46-48).

28. With respect to claims 43 and 44, Knittel discloses the visual representation value associated with the voxel as being a gray scale (claim 43)/color value (claim 44)(col.4, ll.34-38—bones and muscle possess color, and a gray scale is an array of colors).

29. Finally, concerning claims 46 and 47, Knittel discloses said point associated visualization value comprising a volume lighting value (claim 46)/surface lighting value (claim 47) (col.4, ll.34-38—color always has a lighting value).

30. In view of the foregoing, the examiner concludes that claims 19, 28, 42-44, 46 and 47 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Argiro in view of

Drebin and further in view of Knittel.

31. Claim 40 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Argiro in view of Drebin and further in view of Ogata et al. ("Ogata", U.S. Pat. No. 6,313,841).

32. Neither Argiro nor Drebin disclose parallel cast rays. However, this element is disclosed by the Ogata volume rendering system at col.1, ll.11-16.

33. Therefore, it would have been obvious to one of ordinary skill in the art to have modified the Argiro-Drebin rendering system in view of the Ogata method of casting rays in parallel. This would produce a two-dimensional projection of a three-dimensional dataset, allowing the viewer to focus on specific details (Ogata, col.1, ll.11-16).

34. In view of the foregoing, the examiner concludes that claim 40 has been rendered unpatentable by Argiro, Drebin and Ogata.

35. Finally, claim 48 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Argiro in view of Drebin and further in view of Deutsch et al. ("Deutsch", U.S. Pat. No. 5,417,958).

36. Neither Argiro nor Drebin disclose the advancement along a ray coordinated with an opacification process. These elements are taught by the Deutsch X-ray contrast imaging method at col.1, ll.15-25.

37. Therefore, it would have been obvious to one of ordinary skill in the art to have modified the Argiro-Drebin rendering system in view of the Deutsch method. Such a modification to Argiro-Drebin allows imaging of organs, vessels and tissues (Deutsch, col.1, ll.21-22).

38. In view of the foregoing, the examiner concludes that claim 48 has been rendered

unpatentable by Argiro, Drebin and Deutsch.

***Conclusion***

Any inquiry concerning this communication or earlier communications from the Office should be directed to the examiner, Lance Sealey, whose telephone number is (703) 305-0026. He can be reached Monday-Friday from 7:00 am to 3:30 pm EDT.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Zimmerman, can be reached at (703) 305-9798.

**Any response to this action should be mailed to:**

MS Non-Fee Amendment

Commissioner for Patents

P.O. Box 1450

Alexandria, VA 22313-1450

**or faxed to:**

**(703) 872-9314 (for Technology Center 2600 only)**

Hand-delivered responses should be brought to Crystal Park II, 2121 Crystal Drive, Arlington, VA, Sixth Floor (Receptionist).

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Technology Center 2600 Customer Service Office at (703) 306-0377.

Matthew C. Bella

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